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STRATIGRAPHY OF THE EARLY EOCENE PASS PEAK FORMATION, CENTRAL-WESTERN WYOMING[1]

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INTRODUCTION

Stratigraphic investigation of the Pass Peak Formation was carried out for a total of seven months in the field during the summers of 1965, 1966, and 1967 in order to provide the necessary framework for interpreting detailed information concerning its provenance, dispersal, depositional environment(s) and tectonic history. The purpose of this paper is to summarize the stratigraphic information gathered in this study.

The area of investigation occupies approximately 700 square miles in Sublette and Teton counties (Fig. 1). The northern one-fourth of the area is in the Hoback Basin; the remainder extends southward into the northern part of the Green River Basin. The two basins are separated by a drainage divide called The Rim. The Hoback Basin is bounded on the west by the Hoback Range and on the north and northeast by the Gros Ventre Range. The Wind River Range lies to the east of the Gros Ventre Range and extends southward, forming the eastern boundary of the Green River Basin. The western edge of the basin is bounded by the Wyoming and Hoback Ranges.

Precambrian igneous and metasedimentary rocks are exposed along the southwest flank of the Gros Ventre Range and throughout the entire core of the Wind River Range. These exposures are the result of primarily vertical uplift along high angle reverse faults in the relatively thin sediments of the foreland. Paleozoic and Mesozoic sediments are exposed along the flanks of the Gros Ventre and Wind River ranges and Mesozoic sediments are well exposed throughout the Hoback Range where they are cut by a complex series of eastwardly directed thrust faults. Paleocene and Eocene rocks are exposed on the north flank of the Gros Ventre Range and throughout the Hoback and northern Green River basins. Conglomerates and sandstones of Miocene and Pliocene age outcrop north of the Hoback Basin between the Hoback and Gros Ventre ranges. A generalized geologic map of central-western Wyoming is shown in Figure 2.

The Pass Peak Formation was first named by Eardley *et al.* (1944) from Pass Peak, a high point on the Hoback-Green River divide, where it outcrops in a slide scar 1,800 feet high. Using the lowest yellow sandstone as the base of the formation, they mapped its distribution over much of the southern and eastern part of the Hoback Basin, extending it northward between the Hoback and Gros Ventre ranges. Dorr (1958) remapped the Pass Peak using the lowest conglomerate as the base. He placed the sandstone beneath this in his so-called "transition zone." Using this criterion, he limited the distribution of the Pass Peak to a smaller area in the southern and eastern portions of the basin. Keefer (1964) demonstrated that the Pass Peak Formation was involved in the faulting along the southernmost part of the Gros Ventre front. Antweiler and Love (1967, p. 7) described the occurrence of gold in the Pass Peak. On the basis of vertebrate evidence, Dorr (1969) determined that the age of the Pass Peak ranges from Late Graybullian (late Early Wasatchian) through Lysitean

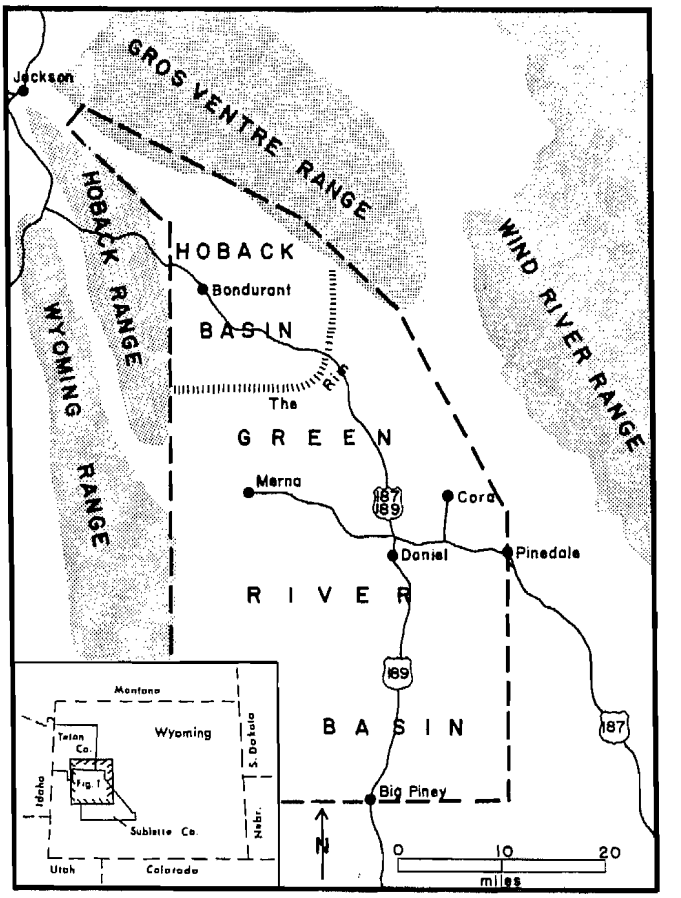

Fig. 1.—Map of the major physiographic features of central-western Wyoming. The area of investigation is enclosed by a dashed line.

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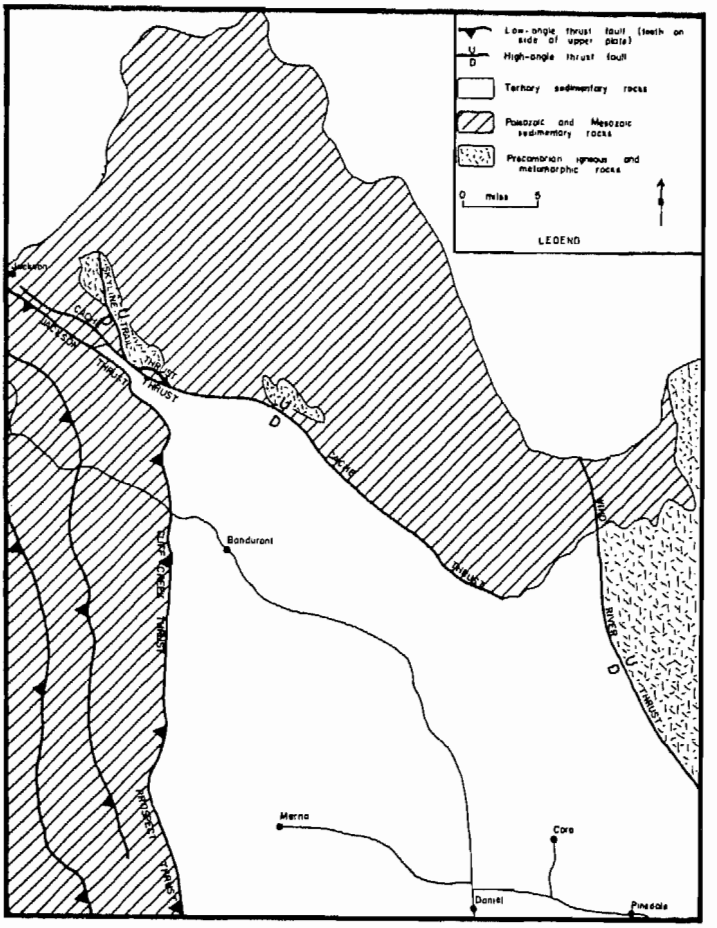

Fig. 2.—Map showing the generalized geology of central-western Wyoming.

(Middle Wasatchian), and possibly into Early Lostcabinian (early Late Wasatchian).

IDENTIFICATION AND DISTRIBUTION

Certain general characteristics of the Pass Peak are distinctive enough to serve as criteria for identification of the formation where there is good exposure. The sandstone units are characteristically tan to yellow, poorly cemented, heavily stained with limonite, round weathered, cross-bedded and contorted. The conglomerate is composed almost entirely of well-rounded, pressure-marked quartzite clasts in a sandstone matrix similar to that of the sandstone units. However, where exposure is poor the gross characteristics of the sandstone are not sufficient for positive identification of the formation. For this reason it was necessary to establish additional criteria which would serve as an adequate basis for differentiating the Pass Peak from other Tertiary sediments in the area. The results of heavy mineral and grain count analyses indicate that, in addition to the gross lithologic characteristics listed above, the sandstones are characterized by a distinctive assemblage of light and heavy minerals. Garnet (av. = 51.3%) and opaque minerals (av. = 22.7%) are predominant in the nonmagnetic heavy mineral suite and quartz (av. = 56.4%), feldspar (av. = 19.1%) and rock fragments (av. = 12.9%) are predominant in the light mineral suite.

A generalized map outlining the distribution of the Pass Peak Formation is shown in Figure 3. The problem of determining this distribution was essentially one of (1) distinguishing Pass Peak sandstones from those of the underlying Hoback Formation, (2) determining the southward extent of the Pass Peak Formation and its stratigraphic relations with the Eocene sediments of the northern Green River Basin, and (3) distinguishing Pass Peak conglomerate from other conglomerates in the Hoback and Gros Ventre ranges.

Heavy and light minera' analyses indicate that, in the Hoback Basin, the contact between the Hoback and Pass Peak formations is gradational as well as intercalated. The contact is placed at the base of the lowest laterally continuous sandstone

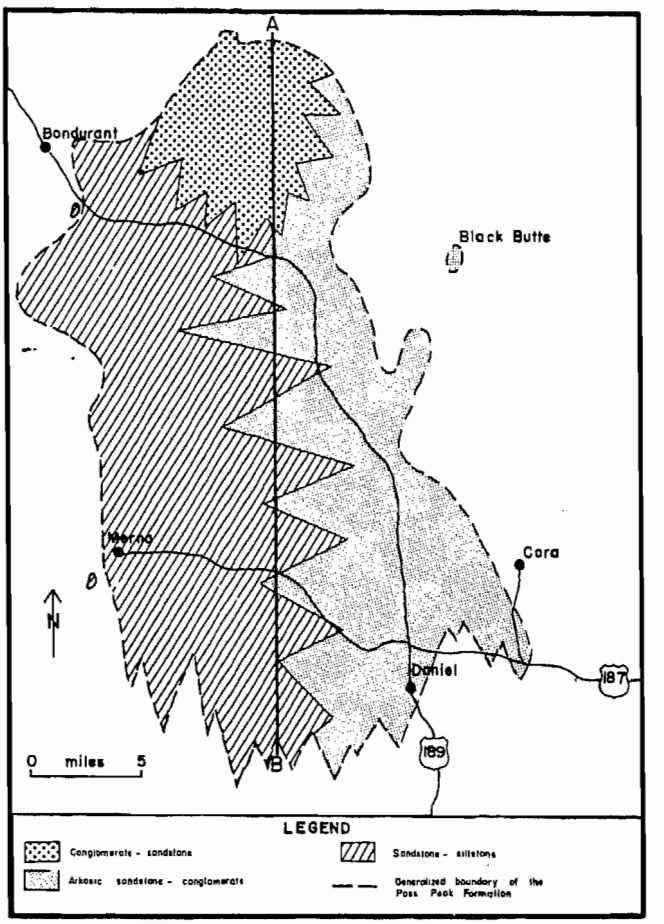

Fig. 3.—Map showing the distribution and lithofacies of the Pass Peak Formation. Cross-section A-B shown in Fig. 4.

with typical Pass Peak composition. Below this level, sandstones which have a composition similar to that of the Pass Peak occur in the Hoback Formation. Conversely, the Pass Peak contains beds of Hoback-like sandstone.

In the north, Pass Peak sandstone is in fault contact with deformed and uplifted Paleozoic and Mesozoic sediments on the southwestern flank of the Gros Ventre Range. In the same area, folded Hoback sandstone is overlain by tilted Pass Peak sandstone and conglomerate. This angular unconformity disap-

pears toward the center of the basin where the contact is as described above.

Sandstones of the Pass Peak extend as far south as Daniel where they interfinger with red and gray variegated mudstones of the LaBarge Member of the Wasatch Formation identified by Oriel (personal communication, 1967). Tongues of the Pass Peak may extend farther south, but in this study, this zone of intertonguing with the LaBarge mudstones is considered its southern limit.

On the east, the Pass Peak Formation is overlain by glacial outwash and recent stream gravel in the valley of the Green River. The easternmost exposure of Pass Peak, isolated in outcrop from the main body of the formation, is on Black Butte, which was apparently a topographic high on the pre-glacial landscape and not covered by subsequent outwash.

In most cases, careful examination of the clast composition is sufficient to distinguish between Pass Peak conglomerate and other conglomerates in the area. Where there was any doubt, thin sections and heavy minerals were examined. No other conglomerate examined consists almost entirely of well-rounded, pressure-marked quartzite clasts in a sand matrix characterized by a high percentage of garnet in the heavy mineral suite.

Conglomerate exposed along the west edge of the Hoback Basin on the flank of the Hoback Range and mapped as Pass Peak by Foster (1943), Eardley *et al.* (1944) and Froidevaux (1968), as well as the conglomerate exposed just west of Merna and mapped as Early Eocene undifferentiated by Armstrong and Oriel (1965) has neither the gross lithologic characteristics nor the heavy mineral composition of the Pass Peak Formation. Although many of the clasts are round, pressure-marked quartzite, at least 50 percent of those counted are angular fragments of Mesozoic sedimentary rock. In addition, the matrix is composed of red and gray silty sandstone with a heavy mineral suite characterized by well-rounded zircon and no garnet. This conglomerate may overlie the Pass Peak along the western part of The Rim; but field evidence is, as yet, inconclusive.

A conglomerate exposed to the north between the Gros Ventre and Hoback ranges has also been called Pass Peak. However, the gross lithologic characteristics are unlike anything seen in Pass Peak conglomerate. Pebble counts by Lynch (1948) indicate that 60 to 80 percent of the clasts in this conglomerate are composed of locally derived sedimentary rock fragments. Furthermore, the matrix is almost entirely red, silty sandstone. The Pass Peak Formation is thickest in the northernmost part of the area where approximately 1,900 feet of conglomerate are exposed. It apparently thins to the south and southwest. Outcrops just south of the point where Highway 187-189 crosses The Rim are at about the same stratigraphic level as the uppermost exposures to the north and some 1,500 feet above the Hoback-Pass Peak contact where it crosses the highway in the Hoback Basin. These figures represent only present exposed thickness since no younger strata overlie the Pass Peak in this area and the amount of material removed by erosion is not known.

LITHOFACIES AND THEIR RELATIONS

Three major lithofacies are defined in the Pass Peak Formation: (1) conglomerate-sandstone, (2) sandstone-siltstone, and (3) arkosic sandstone-conglomerate. The distribution of these facies is shown in Figure 3. The conglomerate-sandstone facies is composed almost entirely of conglomerate in the northern part of the area where it outcrops along Jack Creek. Toward the south and southwest, sandstone units interbedded with the conglomerate become increasingly abundant, thicker, and more widespread and only channel conglomerates persist. The southern and western limit of this facies is defined by the complete absence of conglomerate channels in the sandstone. There is insufficient exposure to determine the eastern extent of this facies, and this boundary has been inferred.

The major sandstone units of the conglomerate-sandstone facies are continuous to the south where they thin and become interbedded with thick siltstone and silty shale beds and thin limestone lenses. This sequence constitutes the sandstone-siltstone facies which extends to the southern boundary of the formation.

The arkosic sandstone-conglomerate facies constitutes the eastern portion of the Pass Peak Formation. The easternmost outcrop is on Black Butte in the valley of the Green River. The northern extent of this facies has been inferred because of insufficient exposure. Massive beds of arkosic sandstone and conglomerate are exposed in the canyon of the Green River east of Highway 187-189. These beds thin to the west and interfinger with the sandstones of the sandstone-siltstone facies. Pebbly, arkosic sandstone occurs as lag sediment at the base of small channels and scours throughout the sandstone-siltstone facies, but the limit of the arkosic sandstone-conglomerate facies is defined as the westernmost extent of distinct lenses or beds of arkosic sandstone and conglomerate.

The relations between the three lithofacies of the Pass Peak Formation are shown in the cross-section in Figure 4. Figures 5, 6, and 7 show a generalized stratigraphic section from the conglomerate-sandstone facies, a composite measured section between the sandstone-siltstone and conglomerate-sandstone facies, and a measured section from the sandstone-siltstone facies.

REGIONAL STRATIGRAPHIC RELATIONS

As previously noted, the age of the Pass Peak Formation ranges from Late Graybullian through Lysitean and possibly into Early Lostcabinian (Dorr, 1969). Interfingering of at least some Pass Peak sandstone units with red and gray siltstones of the LaBarge Member of the Wasatch Formation is visible in the exposures south of Daniel. The light and heavy mineral composition of LaBarge sandstone samples collected southwest of Big Piney is similar to that of Pass Peak sandstone except that hornblende, rock fragments, and highly altered grains are somewhat more abundant.

Many fossils collected by Gazin (*in* Oriel; 1962, p. 2170) from the LaBarge Member are of Lysitean and/or Early Lostcabinian age. All of these are, however, from the

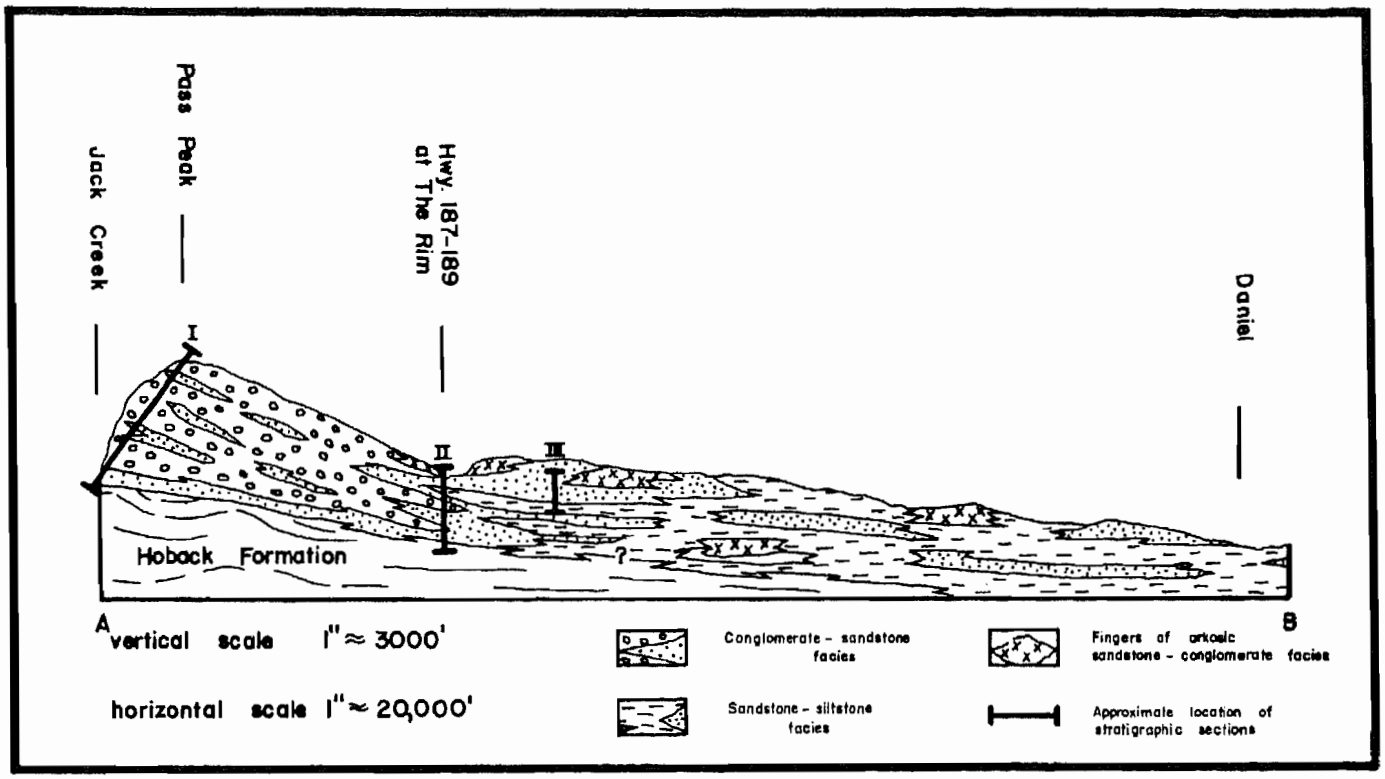

Fig. 4.—A north-south schematic cross-section showing the relations between the three lithofacies of the Pass Peak Formation. Stratigraphic sections I, II, and III are shown in Figures 5, 6, and 7.

uppermost levels of the member and the precise age of the lowest beds of the LaBarge is not known. A tentative Lysitean age for the lowest beds is suggested by Oriel (1962, p. 2170) from other fossil evidence. The age of the LaBarge Member is therefore considered to be Lysitean (?) and Lostcabinian. More fossil evidence from the upper beds of the Pass Peak and the lower beds of the LaBarge is needed to establish age relations which are unquestionably consistent with the physical relations observed in the field.

The Early Lostcabinian age assignment to the upper levels of the Pass Peak is supported by two observations: (1) interfingering of Pass Peak sandstone with the Fontenelle Tongue of the Green River Formation, and (2) the Pass Peak-like composition of sandstones of the New Fork Tongue of the Wasatch Formation. Both the Fontenelle and New Fork are of Lostcabinian age (Oriel, 1962). At the base of Cora Butte just northeast of Daniel, sandstone units of the arkosic sandstone-conglomerate facies of the Pass Peak interfinger with fine, gray sandstones and siltstones tentatively identified as Fontenelle by Dorr (personal communication 1967). West (1968, p. 47) has identified a coarse feldspathic sandstone unit south of Pinedale as part of the New Fork Tongue. This sandstone has the same composition as the arkosic sandstone and conglomerate in the Pass Peak, but it cannot be traced northward into the Pass Peak. Therefore, this correlation must be considered tentative.

The conglomerate which may overlie the Pass Peak on the west along The Rim may be a northern extension of the Conglomerate Member of the Wasatch Formation. It is very similar to the description of Wasatch conglomerate given by Oriel (1962, p. 2170). However, more work must be done in this area to determine what stratigraphic level this conglomerate represents, if indeed, it is Wasatchian. Most of the Conglomerate Member of the Wasatch Formation to the south is of Lostcabinian age. Whether any part of it is as old as Lysitean cannot be determined (Oriel; 1962, p. 2171).

The Chappo Member of the Wasatch Formation, of latest Paleocene (Clarkforkian) and earliest Eocene (Graybullian) age, lies directly below the LaBarge and is separated from it by an angular unconformity (Oriel; 1962, p. 2164). However, unconformable relations between the Pass Peak and the Hoback Formation, which is in part time equivalent to the Chappo, are limited to the extreme northern end of the Hoback Basin. To the south, the intercalated and somewhat gradational nature of the Hoback-Pass Peak contact indicates continuous deposition. It is not known how far north the Chappo-LaBarge unconformity extends.

Figure 8 is a schematic fence diagram showing the inferred stratigraphic relations of the Pass Peak and Hoback formations with the Paleocene and Eocene sediments in the northern Green River Basin.

STRUCTURAL INVOLVEMENT

The Pass Peak Formation is involved in basin flank structures on the north and west sides of the Hoback Basin. The lower major sandstone unit which outcrops for about

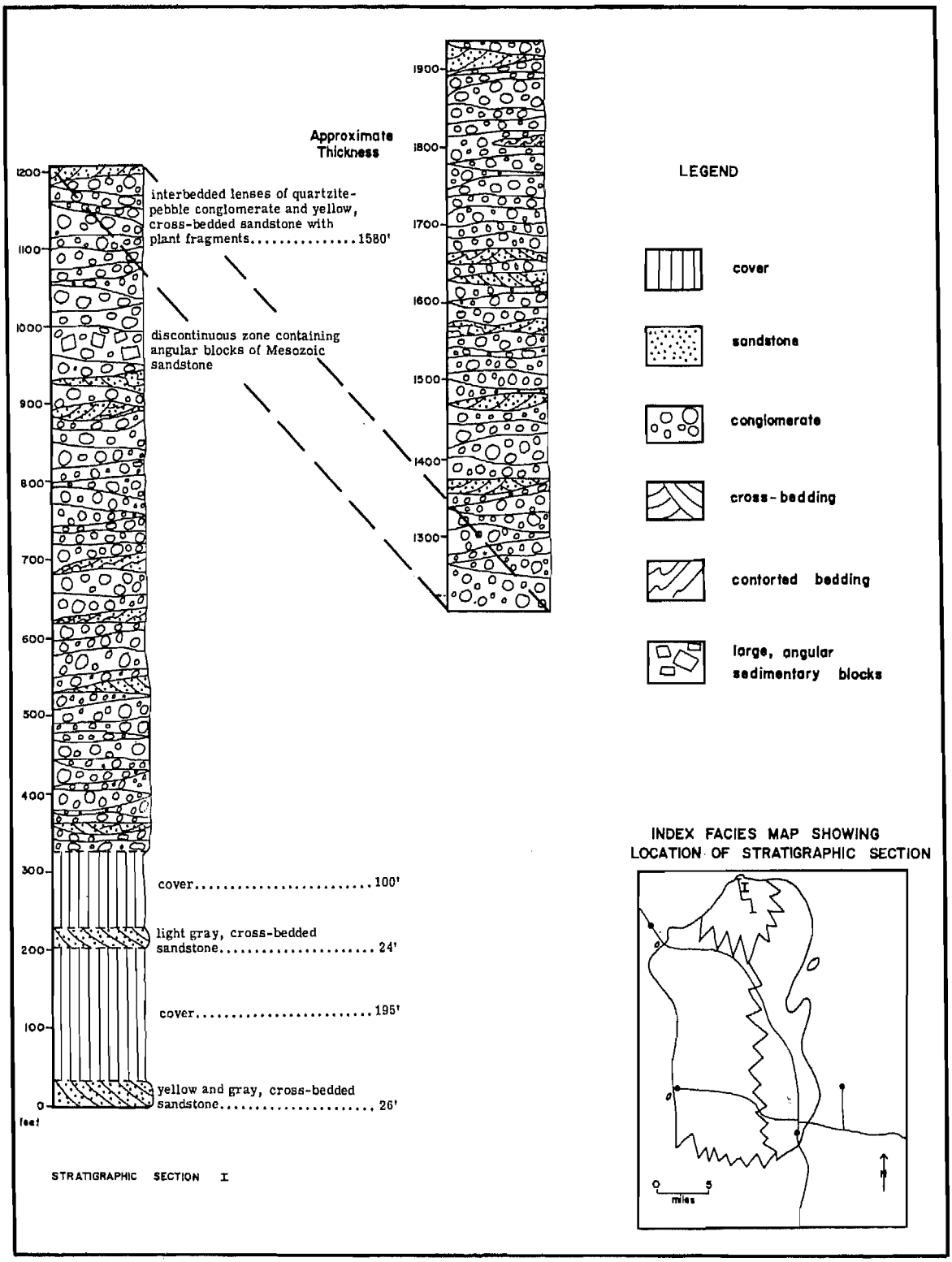

Fig. 5.—A generalized stratigraphic section of the conglomerate-sandstone facies.

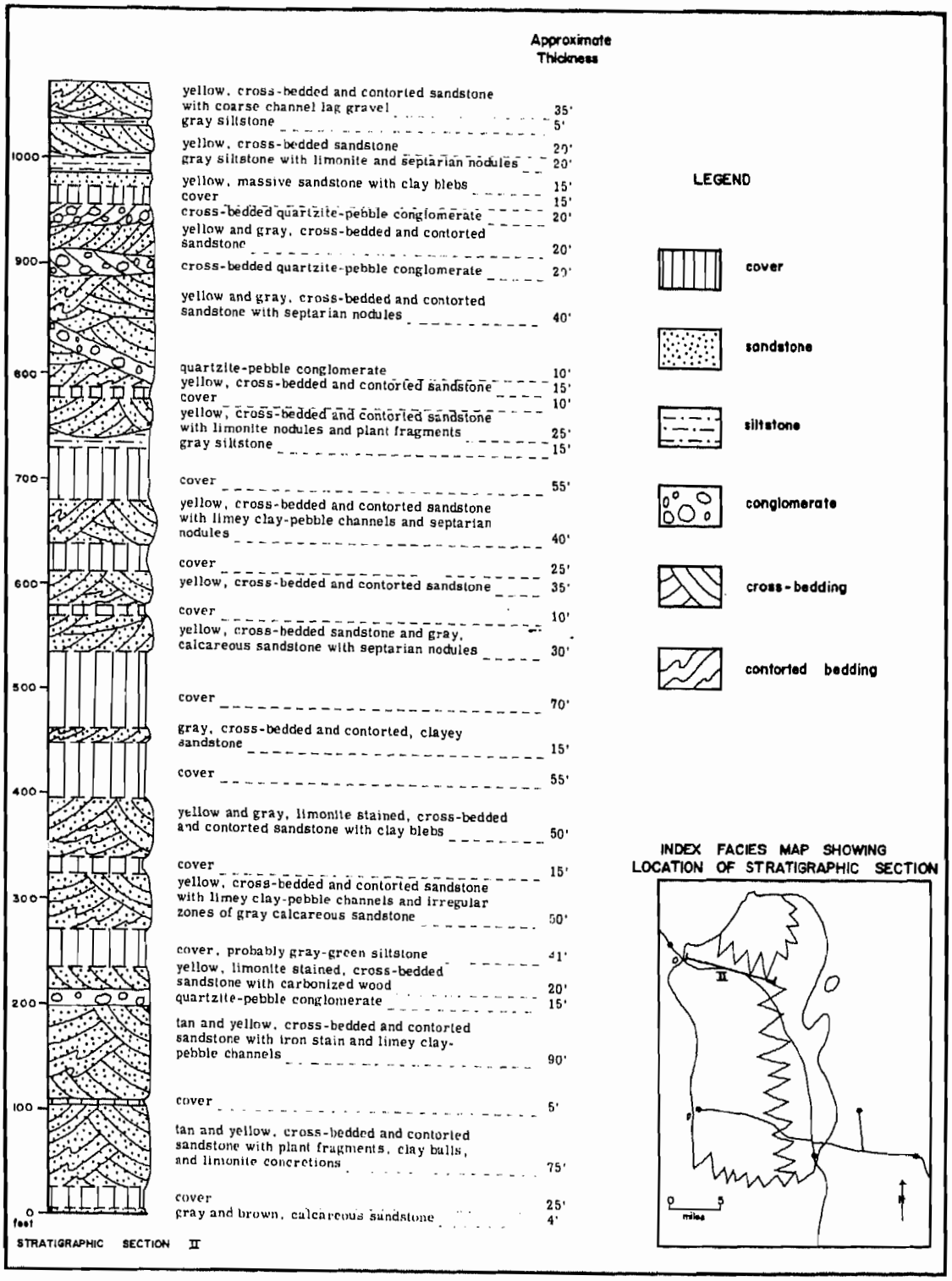

Fig. 6.—A composite stratigraphic section from near the boundary between the conglomerate-sandstone and sandstone-siltstone facies. Measured along Highway 187-189 west of The Rim.

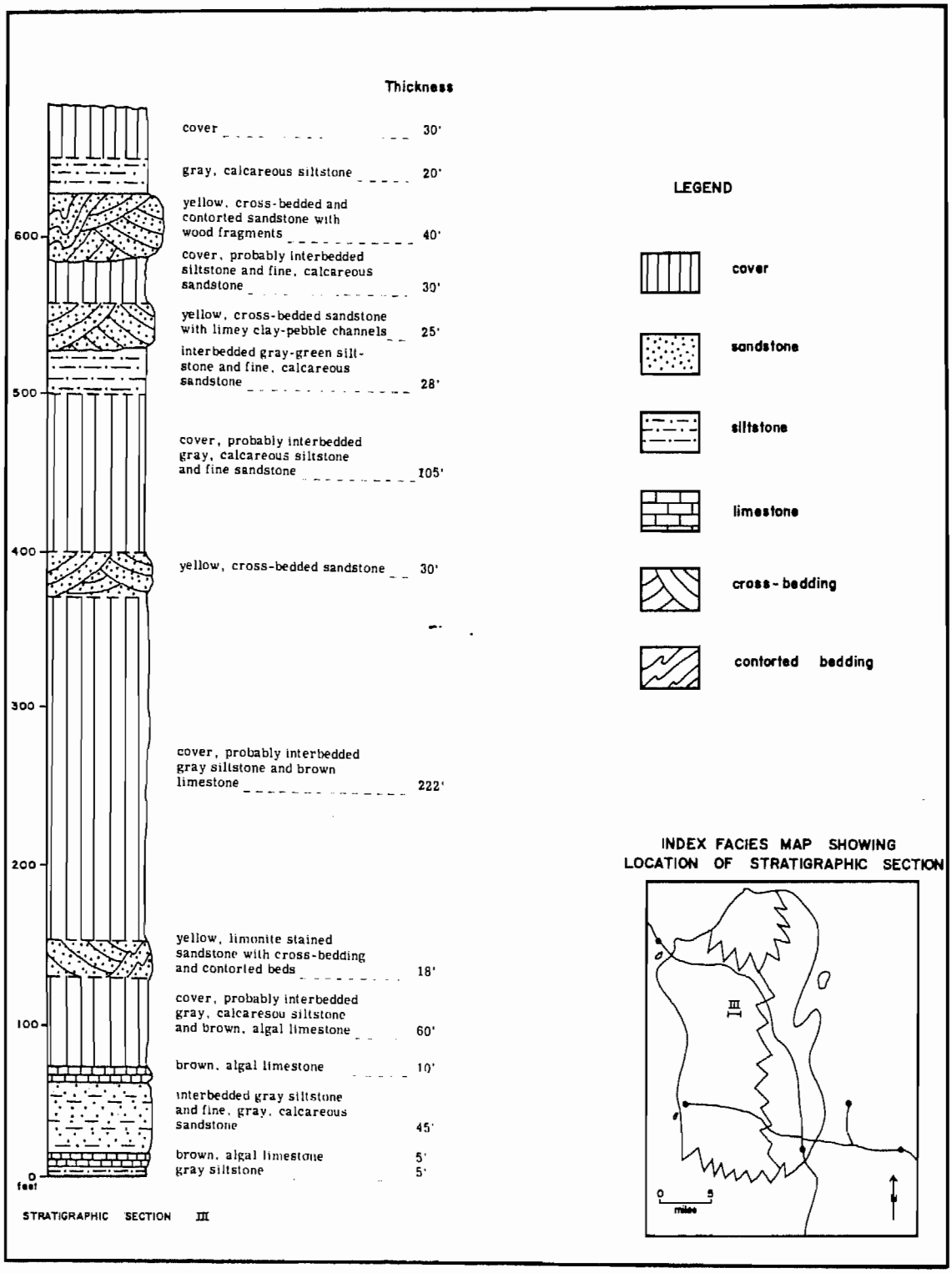

Fig. 7.—A measured section of the sandstone-siltstone facies.

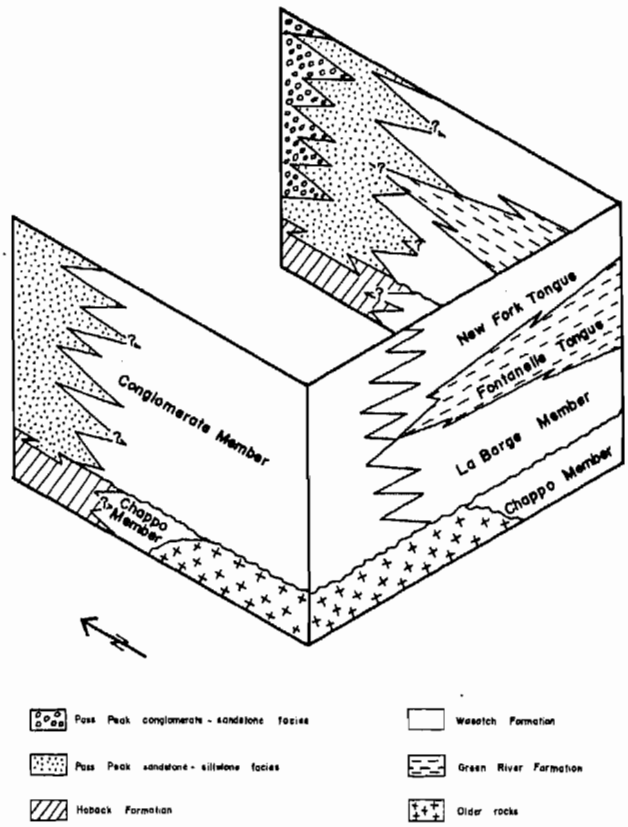

Fig. 8.—Idealized isometric fence diagram showing the inferred regional stratigraphic relations of the Pass Peak Formation. East-west portion of the fence adapted from Oriel (1962, Fig. 2).

three miles along the Hoback River dips 4° E. This determination was made using plane table and alidade. The dip decreases rapidly to the east and no other accurate measurements could be made. This dip is, in part, opposed to the initial dip of the formation and therefore must be of tectonic origin.

Dips as high as 35° SW were recorded in Pass Peak sandstone against the southwest flank of the Gros Ventre Range. Keefer (1964) recorded dips as high as 50° SW in this area, and there is little doubt that the contact between the Pass Peak and the older deformed rocks of the Gros Ventre Range is, for the most part, tectonic. The Pass Peak is turned up sharply immediately adjacent to the Cache fault, but the dip decreases rapidly southward to only 4°S., and may represent only initial dip.

DEPOSITIONAL ENVIRONMENT

Three depositional environments, corresponding to the three lithofacies, can be delineated in the Pass Peak. The semicircular shape, location against the Gros Ventre front, apparent depositional slope, and coarseness of the detritus of the conglomerate-sandstone facies strongly suggest that these sediments were deposited in an alluvial fan environment (Eckis, 1928; Beaty, 1963; Bull, 1963; Denny, 1965).

The arkosic sandstone-conglomerate facies probably represents deposition by braided streams on an alluvial plain. Although the meager exposure of this facies does not permit a conclusive interpretation, the location and inferred distribution of this facies suggests a broad apron of sediment which paralleled the trend of the Wind River Range. Its present distance from the mountain front and the absence of deep channeling or very coarse detritus point to deposition somewhat farther from the source than an alluvial fan. The absence of fine clastics of overbank origin indicates low sinuosity or braided streams (Moody-Stuart; 1966, p. 1104).

Sediments of the sandstone-siltstone facies represent a typical floodplain sequence. The tabular sandstone bodies encompassed by a siltstone envelope, the cross-bedded, scoured, and channeled nature of the sandstone, and the presence of both terrestrial and aquatic fossils are indicative of floodplain deposition (Allen, 1965). Comparison of the observed characteristics of these sediments with the characteristics of recent alluvial sediments facilitates recognition of channel, overbank, and transitional deposits (Allen; 1964, p. 127). The channel deposits are represented by channel-lag gravel and bar sandstones, the overbank deposits by floodplain siltstones, and the transitional deposits by thin freshwater limestones.

CONCLUSIONS

Sediments of the Early Eocene Pass Peak Formation were deposited in an intermontane basin flanked on the northeast by the Gros Ventre Range, on the east by the Wind River Range, and on the west by the Hoback and Wyoming ranges. The basin was filled from the north by quartzite boulders and associated fine clastic sediments derived from the Pinyon Formation and/or its source to the north and from the east by arkosic sediments derived from the Precambrian core of the Wind River Range. These two dispersal systems coalesced in the central portion of the basin and continued southward. Little, if any, debris was shed by the low-standing ranges to the west during the time of deposition of the Pass Peak Formation.

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